No of Pages : 3 Course Code : 12P305

Roll No:
(To be filled in by the candidate)

PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

SEMESTER EXAMINATIONS, MAY - 2015

BE / BE(SW) - PRODUCTION ENGINEERING Semester: 3 / 4

12P305 FLUID MECHANICS AND MACHINERY

Time : 3 Hours **Maximum Marks : 100**

INSTRUCTIONS:
1. Answer **ALL** questions from GROUP – I.
2. Answer any **FOUR** questions from GROUP – II.
3. Answer any **ONE** question from GROUP – III.
4. Ignore the box titled as **"Answers for Group III"** in the Main Answer Book.
5. **Moody's Chart, Fluid properties and Minor loss coefficient tables** are permitted.
6. **Graph Sheet** is to be provided.
7. **State the assumptions wherever necessary while answering Group II and III**
8. **Vector quantities are represented as bold letters throughout the question paper, standard symbols are used.**

GROUP - I **Marks : 10 x 3 = 30**

1. If 1 cup of cream having a density of 1005 kg / m^3 is turned into 3 cups of whipped cream, determine the specific gravity and specific weight of the whipped cream.
2. A ring shaped tube shown in figure 1 contains two ideal gases with equal masses and molar masses M_1 = 32 and M_2 = 28 units. The gases are separated by one fixed partition and another movable stopper *S*, which can move freely without friction inside the ring. Determine the angle α.

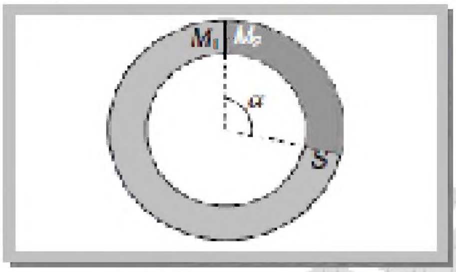

Figure 1

3. Water flows in a pipe so that its velocity triples every 20 seconds. At t = 0, the velocity is 5 m/s. that is, $\mathbf{V} = u(t)\,\mathbf{i} = 5\,(3^{t/20})\,\mathbf{i}$ m/s. Determine the acceleration when t= 10 s and 20 s.
4. Determine the equation of the streamline for a flow whose velocity field is given by $\mathbf{V} = c(x^2 - y^2)\,\mathbf{i} - 2\,cxy\,\mathbf{j}$, c is a constant.
5. For a certain incompressible, two-dimensional flow field, the velocity component in the y direction is given by $v = 3xy + x^2y$. Determine the velocity component in the x direction if the volumetric dilation rate is zero.
6. The stream function for a two dimensional, incompressible flow field is given by the expression $\Psi = -0.6\,(x - y)$. If the flow is irrotational, determine the corresponding velocity potential function.
7. Bring out the meaning of the term "Reynolds number independence".
8. What is the condition in which minor losses in pipes are higher than the major losses?
9. How can a spinning football generate lift during flight? What is the name of this effect?

10. What is the necessity of draft tubes in reaction turbines?

GROUP - II **Marks : 4 x 12.5 = 50**

11. A square block with side "*a*" mm slides across a flat plate on a thin film of oil. The oil has viscosity μ and the film is "h" mm thick. The block of mass M moves at steady speed U under the influence of a steady force F. If the force is removed suddenly and the block begins to slow, roughly sketch the resultant speed versus time curve for the block. Obtain an expression for the time required for the block to lose 95% of its initial speed.

12. A flow is described by a velocity field $\mathbf{V} = ay\ \mathbf{i} + bt\ \mathbf{j}$, where $a = 1\ s^{-1}$ and $b = 0.5\ m / s^2$. At t = 2 s, what are the coordinates of the particle that passed through the point (1, 2) at t = 0? At t = 3 s, what are the coordinates of the particle that passed through the point (1, 2) at t = 2 s? Plot the path line of the particle released at t = 0 s through the point (1, 2) and compare with the streamlines through the same point at the instants t = 0, 1 and 2 seconds.

13. The parameters that characterize steady horizontal flight of birds, insects, bats and flying dinosaurs include the wing span *L* (a length), the wing area *A*, the animal's weight *W*, the frequency of wing flapping *f* (in cycles per unit time), the forward speed *V*, the air density ρ and the air viscosity μ.

    a) Choosing *A*, *V* and ρ as repeating parameters, determine all appropriate dimensionless groups for this problem. If possible, convert some or all of these groups into commonly used dimensionless parameters in fluid mechanics.

    b) Consider building a robotic, flying model of a prehistoric flying dinosaur as shown in figure 2. It is estimated that this creature had a wingspan of 11 m and weighed 1350 N. Further, assume that it flapped its wings 20 times per min and had a steady forward flight speed of 10 m/s. The model will be geometrically similar to the animal, as reconstructed from fossilized remains, but, for obvious reasons, it will be made with the smaller wingspan of 2 m. Determine the weight, the forward speed and the wing flapping frequency of the model, as required in order to preserve dynamic similarity. Do you foresee any difficulties with the operation of the model? If so, can you recommend some solution that may be acceptable?

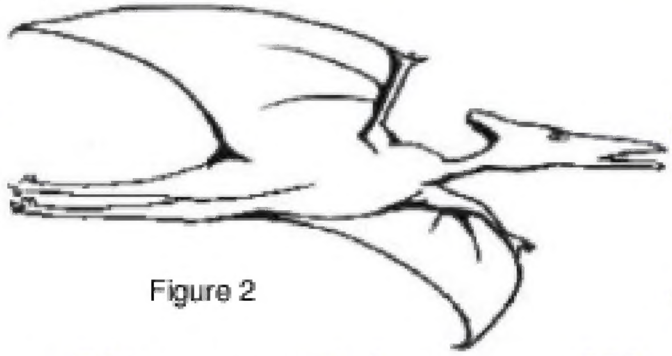

Figure 2

14. The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One-third of the gross head is lost in friction in the penstock. The rate of flow through the nozzle is 2 m^3/ s. The angle of deflection of the jet is 165°. Determine the power supplied to the runner and hydraulic efficiency of the wheel. Take speed ratio = 0.45 and $C_v = 1.0$.

15. Air conditioning for a university campus is provided by chilled water pumped through a main supply pipe. The pipe makes a loop 4800 km in length. The pipe diameter is 0.6 m and the material is steel. The maximum design volume flow rate is 0.7 m^3/s. the circulating pump is driven by an electric motor. The efficiencies of pump and motor are 0.8 and 0.9 respectively. Electricity cost is Rs. 12 / kW. Hr. Determine a) the pressure drop, b) the rate of energy addition to the water, and c) the daily cost of electrical energy for pumping.

GROUP - III **Marks : 1 x 20 = 20**

16. Derive the momentum integral equation for a flat plate boundary layer. For the following velocity profile, evaluate δ^*/δ and θ/δ.

$$\frac{u}{U} = \sqrt{2}\ \frac{y}{\delta} \qquad 0 < y \le \frac{\delta}{2}$$

$$\frac{u}{U} = \left(2-\sqrt{2}\right)\frac{y}{\delta} + \left(\sqrt{2}-1\right) \qquad \frac{\delta}{2} < y \le \delta$$

17. Using an appropriate control volume, show that for a steady, incompressible, inviscid flow, $\rho g - \nabla P = \rho\left[\frac{\partial V}{\partial t} + (V \cdot \nabla)V\right]$. Derive the Bernoulli equation considering the above expression as the starting point and prove that for irrotational flow, Bernoulli equation is not limited to application along a streamline. **[Note: Do not waste time by deriving the Bernoulli equation by direct application of Newton's II law to a fluid particle along a streamline]**

/END/

FD/RL